Energy savings from motor management policies

- Base purchase and repair decisions on life-cycle cost
- Establish the policy that's right for your organisation
- Piggy-back energy saving policies on to existing motor maintenance schemes and plant upgrades
- Consider "Contracting out"

BEST PRACTICE PROGRAMME

ENERGY EFFICIENCY

BEST PRACTICE PROGRAMME

GENERAL INFORMATION LEAFLET 56

INTRODUCTION

INTRODUCTION

Motors typically account for 65% of the average industrial electricity bill, and so taking action to reduce their costs makes sound economic sense. Since over its lifetime a motor can cost 100 times as much in energy as it did to buy, energy efficiency is a key criteria whether buying new or replacing old motors. An increasing number of companies are approaching this issue by implementing site-wide Motor Management Policies (MMPs).

This leaflet takes a critical look at the benefits of implementing MMPs, and why some approaches work better than others.

There is no single recipe for success, and so the approach of this leaflet is to offer a tool-kit of ideas from which companies can put together a cost saving plan which best suits their circumstances. Contracting out some of the work to a competent third party should always be seriously and carefully considered, as this can have many benefits.

Further technical and economic information on all aspects of motor efficiency are in GPG2 *Energy savings with electric motors and drives*, pages 11 - 20.

A motor management policy in its simplest form is a coherent, structured approach to the purchase and repair of a company's motors. It is designed to ensure that the best economic decision is made each time.

Maintenance is essential; saving energy is optional. This means that to many sites, the energy savings made from an MMP, as described in this leaflet, are regarded as the "icing on the cake" which are additional to the reduction in unplanned downtime and other savings from a comprehensive motor maintenance policy.

Therefore, piggy-backing a motor management policy (designed to produce energy savings) on to a motor maintenance policy, will maximise the chances of success.

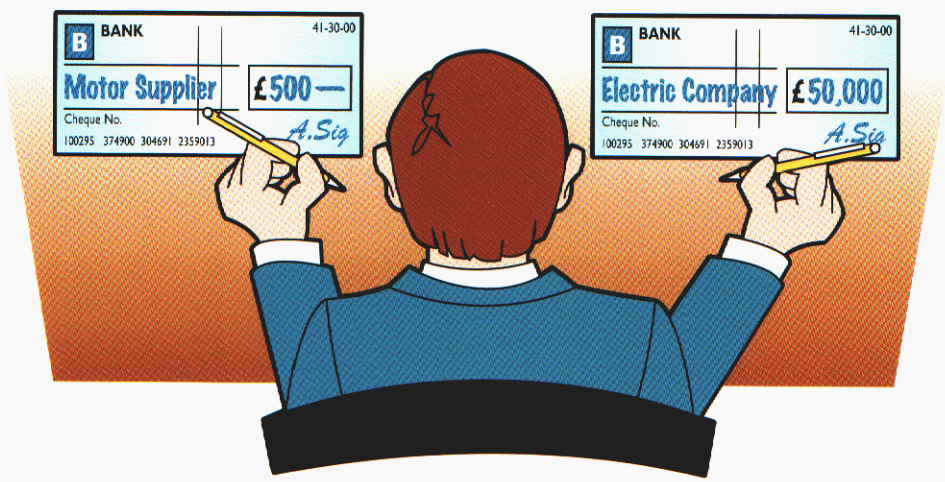


Fig. 1 When you write a cheque for a £500 motor, you could be writing a cheque for £50,000 to the electricity supplier

WHY DO I NEED A MOTOR MANAGEMENT POLICY?

Making a purchase decision based on minimising life-cycle costs (LCCs) might be the logical approach to take, but lowest first-cost arguments usually win unless firm action is taken to change the behaviour of all personnel involved in motor purchasing.

- ***Equipment designer*** – may rely on sub-contractors whose priority is to submit lowest cost designs, which means using less efficient motors.
- ***Purchasing and accounts personnel*** – through lack of information may seek the lowest first-cost unless given clear instructions.
- ***Maintenance personnel*** – want to minimise downtime, avoid additional work that could arise from replacing rather than repairing a failed motor, and minimise expenditure.
- ***Operations personnel*** – are the only people likely to be accountable for the energy bill, and so have an incentive to demand more efficient motors. But energy may only be a small proportion of their total costs and other factors such as meeting production targets are likely to take a higher priority.

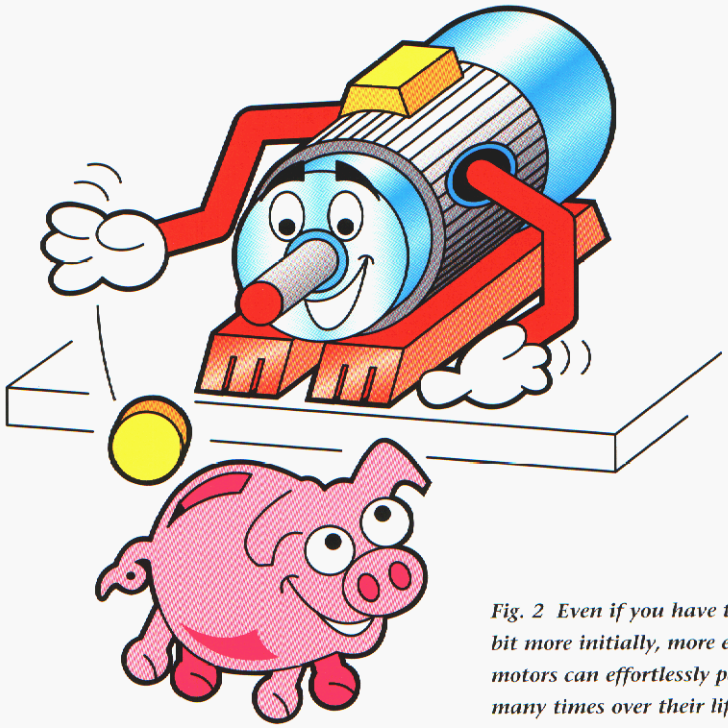


Fig. 2 Even if you have to pay a little bit more initially, more efficient motors can effortlessly pay you back many times over their life.

Problems with Existing Motor Procurement Schemes

Some companies may be constrained by having a stock of 'free' salvaged motors, but using these rather than purchasing new Higher Efficiency Motors (HEMs) may prove to be a false economy.

Standardisation pays, but maybe not if you have standardised on something expensive. Some companies may demand special features from manufacturers, which means that long delivery times cause motors to be repaired rather than replaced. Often such specifications are based on old standards, and a review of standard specifications can produce immediate savings. In other cases, the standard may be set for the most demanding applications, whereas many motors could actually be standard 'catalogue' types.

DESIGNING A MOTOR MANAGEMENT POLICY WHICH IS RIGHT FOR YOUR ORGANISATION

MAKING IT WORK - CRITICAL SUCCESS FACTORS FOR A MOTOR MANAGEMENT POLICY

There are six identifiable stages (see Fig 3) to forming a motor management policy which has a good chance of success.

Fig 3 Essential stages in forming a motor management policy

Writing an Outline Proposal

At an early stage senior management will need to see an outline proposal that describes the benefits to the company, and some ideas for practical implementation.

Winning Senior Management Commitment

Strong and ongoing senior management commitment is a pre-requisite. Lack of this commitment is the main reason for policies failing to work. It is more than just signing up to a policy statement. Senior management must ensure that any necessary changes to existing responsibilities and accounting/monitoring procedures are put into place and are working. Some additional "pump priming" funds may be required to meet any price premiums associated with higher first-cost options.

Deciding the Best Approach

This will begin with analysis of any relevant data available (for instance from asset registers, hours run or energy consumption records). This will give baseline data that will provide an indication of the levels of energy and cost saving that are possible to achieve, and, later, show what is actually being achieved.

Writing the Guidelines

This stage can be used as the basis for discussion with all sections of the organisation influencing or affected by motor purchasing decisions, leading to a jointly agreed policy. Clear, unambiguous advice can then be drawn up which puts the policy into practical terms which everyone can understand.

SYSTEMS AND RESPONSIBILITIES

Defining Systems and Responsibilities

Accounting Systems

Accounting systems may need to be changed to ensure that all budget holders share the interest in lowering LCCs. In particular, the motor purchaser must get sufficient credit for energy savings made by the section which pays the energy bills. This is by no means a simple matter, and the following are just some suggestions worth considering:

- Provision of a special fund from which 'price premiums' for improved efficiency motors can be taken. The accounts department could then independently reconcile these back to the energy bill payer.
- Direct credit scheme, where the energy bill payer pays the motor purchaser directly for all or part of the price premium of an improved efficiency piece of equipment.
- Simply re-allocate department budgets.

Not all organisations even allow for life-cycle costing, or make anyone responsible for energy bills – if yours is one of these – then this is the place to start!

Supplier Dialogue

Dialogue with your motor supplier can be of mutual benefit:

- Local stocking of your most common motor types can overcome long supply lead-times. Even free 'on-site' stocks of spares are sometimes possible.
- A fixed-term framework agreement can allow the development of a deeper understanding of your requirements free from the day-to-day, adversarial, ongoing price-setting discussion that can otherwise dominate.
- A supplier may provide motors on a 'sale or return' basis and lend monitoring equipment to allow you to see the benefit of HEMs on your site.

Devolvement of Responsibility

Responsibility for making decisions which will often involve considerable additional up-front costs, must be devolved. Personnel at the 'sharp end' must be secure in the knowledge that their adherance to the policy will always be supported, even at the expense of short-term additional costs or sometimes delay in completing a job. This will often mean giving maintenance operatives considerably more decision-making powers than previously.

Monitoring and Feedback

A simple scheme to monitor the effectiveness of the policy, and to report the savings back to all personnel should be agreed and implemented. To help this, ensure that any motor supply, repair or maintenance contractors have the provision of feedback reports incorporated into their contracts.

Ongoing monitoring of the progress of the policy is important to measure its success, and to make changes where necessary. Regular feedback to all personnel involved is essential so that they can see the value of the policy and hence remain committed.

Too often, policies that are clearly best for the company, and committed to by individual departments and people, are thwarted by the management systems designed to make the company function smoothly.

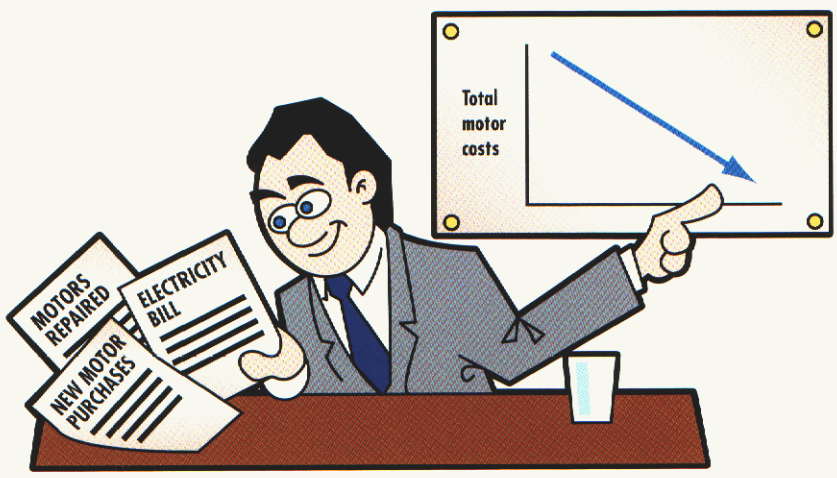


Fig 4 Monitoring and communicating progress is important to maintain committment

DESIGNING THE RIGHT MMP FOR YOUR ORGANISATION – SOME POINTS TO CONSIDER

Who's Driving the Policy?

There needs to be someone, perhaps the Energy Manager, who is given special responsibility for keeping a watchful eye on the progress of the policy, otherwise it is likely that momentum will not be maintained. They must be prepared to fight to maintain the visibility of the scheme at all levels within the organisation.

Capital or Revenue Budget?

See www.eca.gov.uk to find out how to pay less tax on your profits while investing in energy-efficient equipment through the Enhanced Capital Allowance scheme.

The purchase of a new motor is usually funded from the capital budget, and generally requires high/multiple levels of authorisation. However, the Government has introduced an Enhanced Capital Allowance (ECA) scheme to reward businesses that invest in energy-saving equipment. Under the scheme, businesses will pay less tax on their profits when investing in qualifying products such as HEMs (see www.eca.gov.uk). Repairing a motor or replacing like for like (eff1 motor with eff1 motor) you may claim from the revenue budget. Authorisation levels are usually lower with revenue budget and need to be much quicker to allow spending on essential maintenance. For this reason it is often quicker and simpler.

What Sort of Company Structure?

Speak to your local motor suppliers/repairers to find out what motor management agreements they can offer which meet your particular requirements.

Structure is less important than the actual degree of control that senior management have within the company.

Larger companies with dispersed sites and more local autonomy find it hardest to make an MMP work. But because these are often the types of industry with the largest energy saving potential, it is worth the effort. In these cases a pilot scheme at one site is an excellent way of refining a policy before showing the results to other sites as a way of winning them around to the idea. (See the section on "Experiences at NWW").

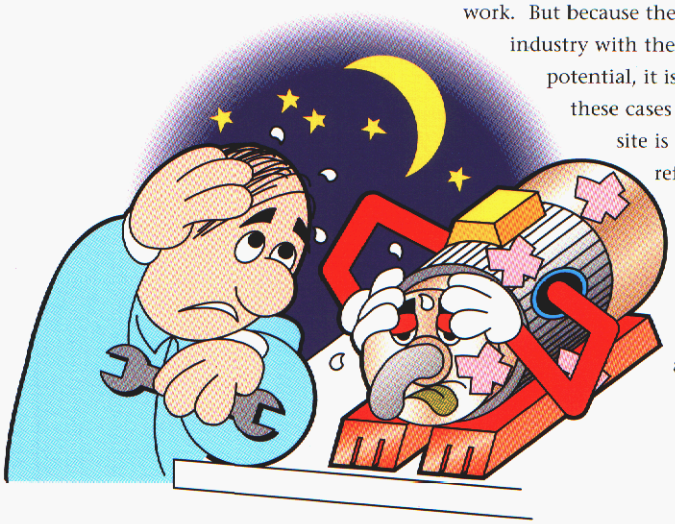


Fig 5 A successful MMP will ensure the right decision is always taken – even at 2 o'clock in the morning

Tight control, either through a strong 'command and control' structure, or in a smaller company where one or two people control everything that goes on, is best for making an MMP work.

Contracting Out

Contracting out all or part of a motor maintenance programme has consistently been shown to give the best results. Essentially, it means that instead of company employees deciding what action needs to be taken, and doing it themselves, a contractor is called to do this instead. This has several key advantages over keeping maintenance in-house:

- The contractor's interest is simply to fulfil the contract – which is based around an agreed MMP.
- Many of the internal conflicts of interest are simply bypassed.
- In-house stock levels can be reduced.
- All internal effort is focused on monitoring the performance of the contractor, so different departments involved find it easier to pull in the same direction.
- Good record keeping by the contractor is more likely because it is linked to real payments.
- The maintenance department is relieved of some of the pressure and can use its efforts in more productive areas.

Of course, some new problems can appear and awareness of the contractor's own specific vested interests should be borne in mind. In practice, the contractor will be a motor repairer/supplier, and so care must be taken to ensure that they do not repair a motor, that should be replaced, simply because it is more profitable for them.

Some companies are moving to full 'keep you working' contracts, whereby a contractor agrees a fixed annual sum for ensuring that all the motors are kept running. This may extend to the contractor carrying out motor health checks to determine which are most likely to fail next, and to then undertake maintenance in a planned way.

Whatever level of contract is entered into, it is important that all parties have access to a common database of site motors to ensure visibility of what is happening.

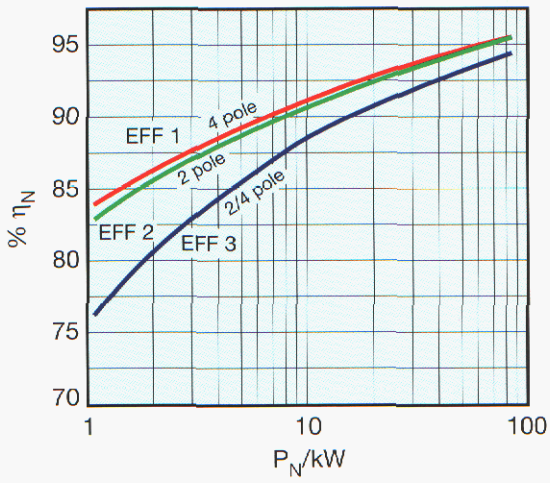
EUROPEAN UNION MOTOR EFFICIENCY CLASSIFICATION SCHEME

Class definition for 4-pole motors

kW	eff3-motors η_N	eff2-motors η_N	eff1-motors η_N
1.1	<76.2	≥76.2	≥83.8
1.5	<78.5	≥78.5	≥85.0
2.2	<81.0	≥81.0	≥86.4
3	<82.6	≥82.6	≥87.4
4	<84.2	≥84.2	≥88.3
5.5	<85.7	≥85.7	≥89.2
7.5	<87.0	≥87.0	≥90.1
11	<88.4	≥88.4	≥91.0
15	<89.4	≥89.4	≥91.8
18.5	<90.0	≥90.0	≥92.2
22	<90.5	≥90.5	≥92.6
30	<91.4	≥91.4	≥93.2
37	<92.0	≥92.0	≥93.6
45	<92.5	≥92.5	≥93.9
55	<93.0	≥93.0	≥94.2
75	<93.6	≥93.6	≥94.7
90	<93.9	≥93.9	≥95.0

Class definition for 2-pole motors

kW	eff3-motors η_N	eff2-motors η_N	eff1-motors η_N
1.1	<76.2	≥76.2	≥82.8
1.5	<78.5	≥78.5	≥84.1
2.2	<81.0	≥81.0	≥85.6
3	<82.6	≥82.6	≥86.7
4	<84.2	≥84.2	≥87.6
5.5	<85.7	≥85.7	≥88.6
7.5	<87.0	≥87.0	≥89.5
11	<88.4	≥88.4	≥90.5
15	<89.4	≥89.4	≥91.3
18.5	<90.0	≥90.0	≥91.8
22	<90.5	≥90.5	≥92.2
30	<91.4	≥91.4	≥92.9
37	<92.0	≥92.0	≥93.3
45	<92.5	≥92.5	≥93.7
55	<93.0	≥93.0	≥94.0
75	<93.6	≥93.6	≥94.6
90	<93.9	≥93.9	≥95.0



Totally enclosed fan ventilated motors

Fig 6 EU-CEMEP AC Induction motor efficiency classification scheme for 400V 50Hz 3-phase (full load efficiency measured in accordance with IEC 34-2)

What is a Higher Efficiency Motor?

Until very recently, there has been no universally agreed definition of a higher efficiency motor (HEM), which made choosing a motor on the basis of efficiency a time-consuming matter of comparing datasheet efficiency. The EU has now introduced a simple motor efficiency classification scheme (see Fig 6), which means that all manufacturers can label their motors according to the efficiency class it falls in to. This has many benefits, not least that it is now easy to stipulate both internally, and to outside suppliers, that your company will for example only specify Efficiency 1 motors. In the UK Class 1 motors are available from leading suppliers at very competitive prices, and so should be specified as the norm (the exceptions are 4-pole motors below 11 kW where a good Class 2 motor may yield a better payback.)

TO REPLACE OR REPAIR?

When a motor fails, the decision to replace or repair is usually based entirely on which will get the plant running in the least time. However, if time is not so critical, then the MMP should give clear guidance as to whether to replace or repair a failed motor, based on minimum life-cycle costs.

Exceptionally, larger, existing 'standard' motors running for long periods may be candidates for replacement before failure – but the payback periods will be unacceptable for most organisations.

Details of the economics of repairing or replacing a failed motor are given on pages 14-15 of GPG2

Generally speaking, the cost difference between repairing or replacing a smaller motor (typically below 5.5 kW to 11 kW) are so small that replacement should be the automatic choice, irrespective of running hours. Conversely, for larger motors, repair is usually more economic, depending on the running hours. In between there is a 'grey area' which usually requires some thought or calculation before the right choice can be made.

Publishing a simple action plan, as in fig 8, is invaluable for helping maintenance staff to 'do the right thing' when under time pressure.

- **Generally, replace or repair according to chart**
- **If below n kW, then REPLACE**
- **If an HEM, then REPAIR**
- **If very badly damaged, then REPLACE**
- **If a motor should be replaced but is needed urgently, then it may be repaired providing that a form is completed to record and justify the action.**

NB: If Imperial design, take account of effort needed to fit a new metric motor

Fig 8 Basis of Motor Management Policy Instructions for dealing with failed motors

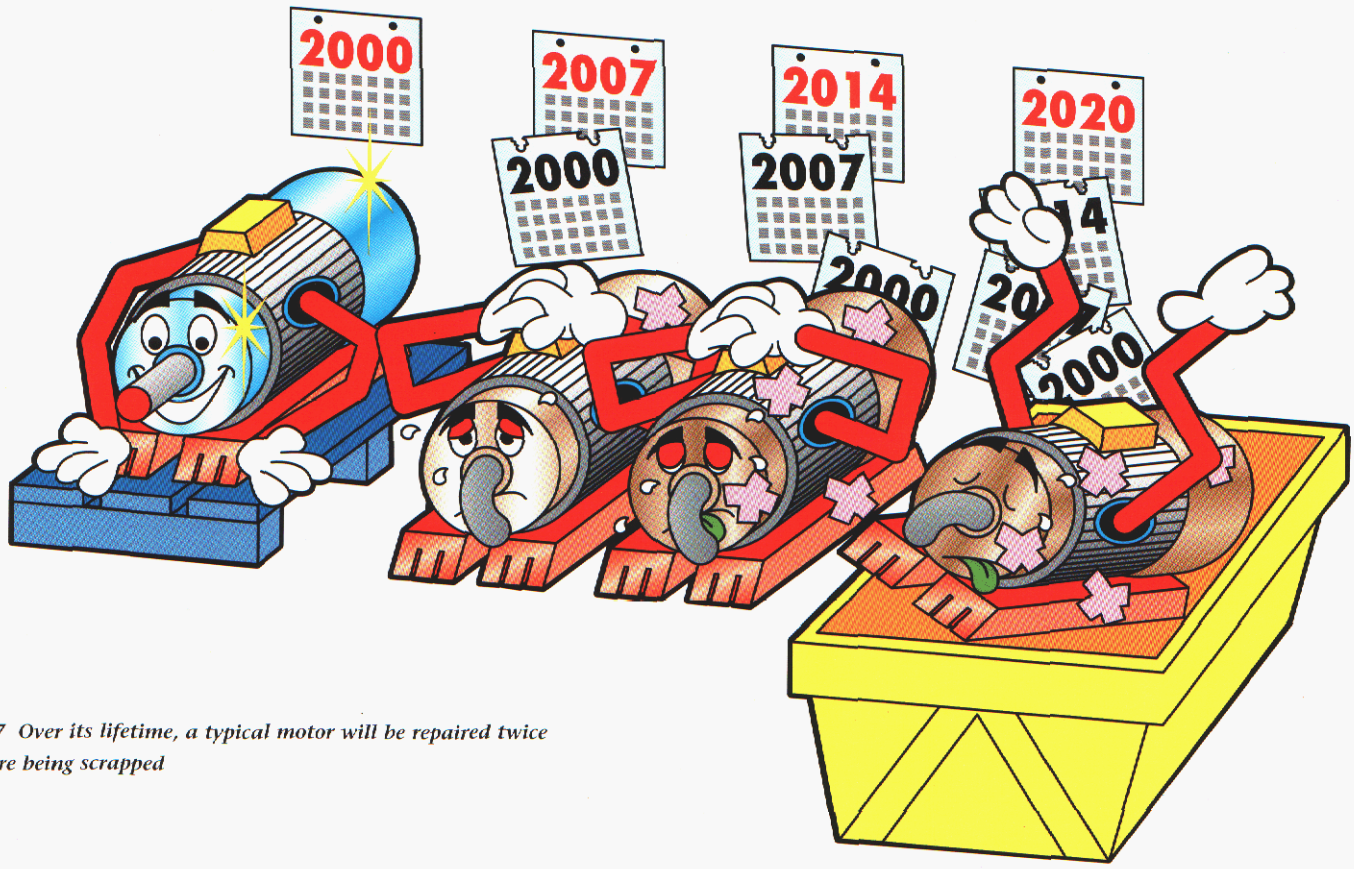
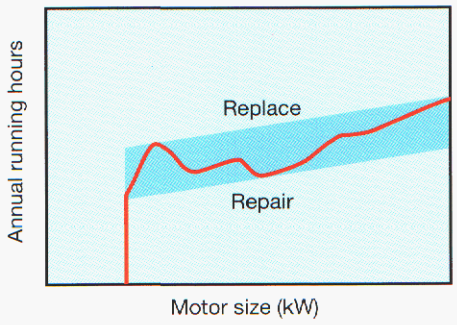


Fig 7 Over its lifetime, a typical motor will be repaired twice before being scrapped

TO REPLACE OR REPAIR?



NB: The shape of the graph above will vary with duty and with local costs – so ask your motor supplier/repairer to help draw up the right guidance for your particular circumstances.

Replace/repair chart

An action plan may also help identify, ahead of actual failure, motors suitable for replacement. Thus, when failure occurs, maintenance staff know excactly what course of action to take.

If measurements of energy consumption are required in order to make more accurate decisions, then ensure that these are carried out before failure occurs. Remember, it is not normally practical to measure the efficiency of a motor under field conditions.

Motor Sizing

When a motor needs replacing, it always easiest to replace it with a 'look alike' motor. But if it is grossly over-sized, for example always working at less than 40% capacity, it might be worth considering replacement with a more correctly (smaller) sized motor. This will reduce the purchase cost and usually energy costs too. The cost of any new mechanical mounting arrangements will need to be taken into account.

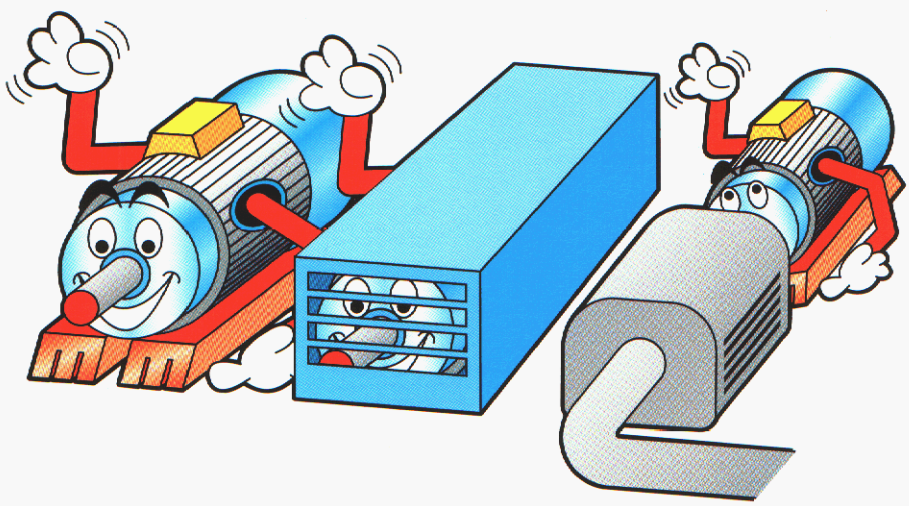
> Some sites swap motors around to get a better matching of size to application with no additional purchase cost.

Asset Management as a Tool for Motor Management

Ideally, any motor management database should include details of:

- motor capacity or rating;
- manufacturer's name and model number;
- frame size;
- mounting details;
- efficiency;
- date of installation;
- date of last major repair/re-wind;
- typical annual running hours (if possible).

See GPG2, pages 16-17 for further information.



Two out of three motors you buy are invisible - they are hidden in other equipment such as fans, pumps and compressors. Don't forget to include these motors in your policy

[1] See GPCS 222 Purchasing Policy for Higher Efficiency Motors, which demonstrates the savings from the implementation of a motor management policy at ECC International.

REPAIRING MOTORS FOR MINIMUM EFFICENCY LOSS

Not only will repairing an old motor deny you the efficiency benefits of an HEM, but during repair the motor is very likely to lose efficiency. A good quality repair, however, should keep this loss in efficiency to less than 0.5%.

The loss in efficiency may be due to such factors as:

- over-heating of the stator core prior to coil-pulling, which can cause a permanent increase in iron losses and decrease in efficiency;
- mechanical damage to stator laminations during disassembly or re-assembly;
- incorrect winding specification – for example too few turns or too narrow gauge of wire;
- incorrect new fan;
- incorrect or badly fitted bearings;
- poor rotor/stator alignment.

Such problems can be minimised by ensuring the work is carried out to an acceptable standard, by choosing a reputable contractor to carry out the work. The joint EEBPP/AEMT Good Practice Guide on the Repair of Induction Motors (Fig 9) provides clear guidance on best practice in motor repair. It is available from the AEMT at the address given at the bottom of this page.

Fig 9 EEBPP/AEMT Guide "The Repair of Induction Motors"

Rushed repairs can be a false economy

Ensure that whoever repairs your motors is aware of best practice and adheres to it. Remember, it is your company that will end up paying for a bad repair in terms of increased energy costs. Check that all repairs are done only at your designated agents – some parts of your organisation may have "local" arrangements with other suppliers which you are unaware of.

Of course, in some cases, motor repair is the safest route. A motor repair could be quicker than getting a new motor, the repaired motor will continue to do the job, the mounting holes will be correct, the shaft diameter, height and keyway arrangement won't have to be changed. But a new motor could be quicker than a repair, especially if held in stock.

Association of Electrical and Mechanical Trades
56 Layerthorpe
York
YO31 7YN

Tel: 01904 674 899
Fax: 01904 674 896

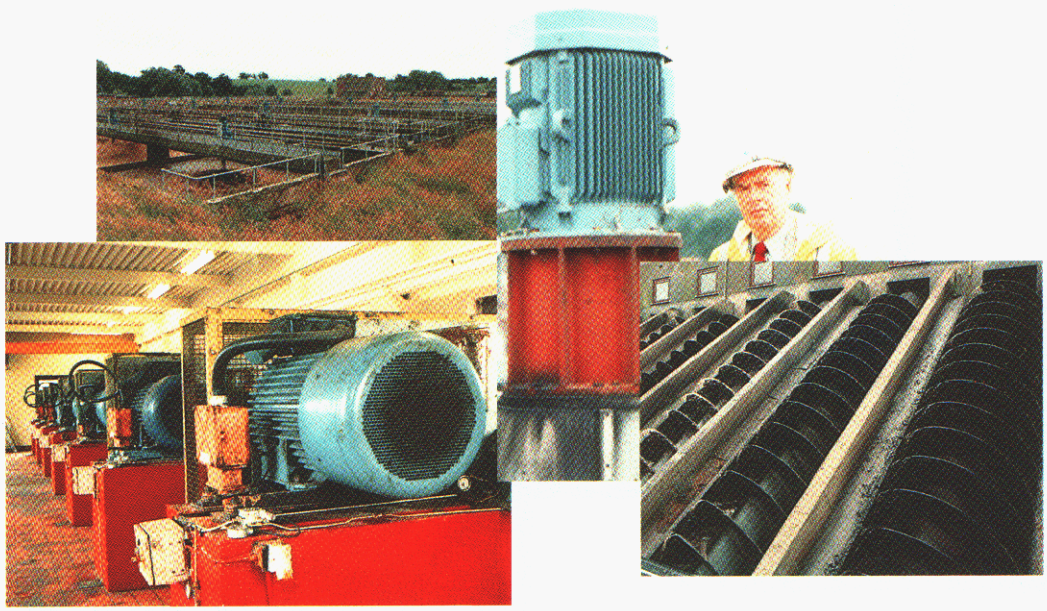
NORTH WEST WATER LTD

NORTH WEST WATER LTD

North West Water Ltd's business is the supply of fresh water to homes and industry in the North West of England, and the treatment of wastewater. Its operating area extends from Market Drayton in Shropshire, northwards to Carlisle and the Scottish border. It is estimated that around 80% of NWW's annual electricity bill of £20 million is attributable to the large number of AC induction motors used to drive pumps, aerators, fans and blowers at their many fresh water supply and wastewater treatment works.

Recognising the potential for reducing the life-cycle costs of purchasing and managing these motors, in 1995 NWW, initiated a pilot Motor Management Policy at several sites. One of these sites is Daveyhulme Waste Water Treatment Works, where 42 motors rated at 37 kW powering a bank of aeration cones are being systematically replaced, on failure, with new high efficiency motors. Savings to date are calculated at over £1,700/year, giving a total potential saving on this plant alone of over £9,000/year.

Although NWW is experiencing some difficulties in ensuring the policy is fully adopted at all of its many sites, it has already been shown to produce very worthwhile savings at a number of sites. The annual energy savings potential of over £300,000/year is encouraging the company to overcome any problems.



The Government's Energy Efficiency Best Practice Programme provides impartial, authoritative information on energy efficiency techniques and technologies in industry, transport and buildings. This information is disseminated through publications, videos and software, together with seminars, workshops and other events. Publications within the Best Practice Programme are shown opposite.

For further information visit our web site at www.energy-efficiency.gov.uk or

for buildings-related topics please contact:

BRECSU
Building Research Establishment
Garston, Watford, WD2 7JR
Tel 01923 664258
Fax 01923 664787
E-mail brecsuenq@bre.co.uk

for industrial and transport topics please contact:

ETSU
Harwell, Didcot, Oxfordshire,
OX11 0QJ
Fax 01235 433066
Helpline Tel 0800 585794
Helpline E-mail helpline@eebpp.org

Energy Consumption Guides: compare energy use in specific processes, operations, plant and building types.

Good Practice: promotes proven energy efficient techniques through Guides and Case Studies.

New Practice: monitors first commercial applications of new energy efficiency measures.

Future Practice: reports on joint R & D ventures into new energy efficiency measures.

General Information: describes concepts and approaches yet to be fully established as good practice.

Fuel Efficiency Booklets: give detailed information on specific technologies and techniques.

Energy Efficiency in Buildings: helps new energy managers understand the use and costs of heating, lighting etc.